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(71) Applicant: **LUCENT TECHNOLOGIES INC.**
Murray Hill, New Jersey 07974-0636 (US)

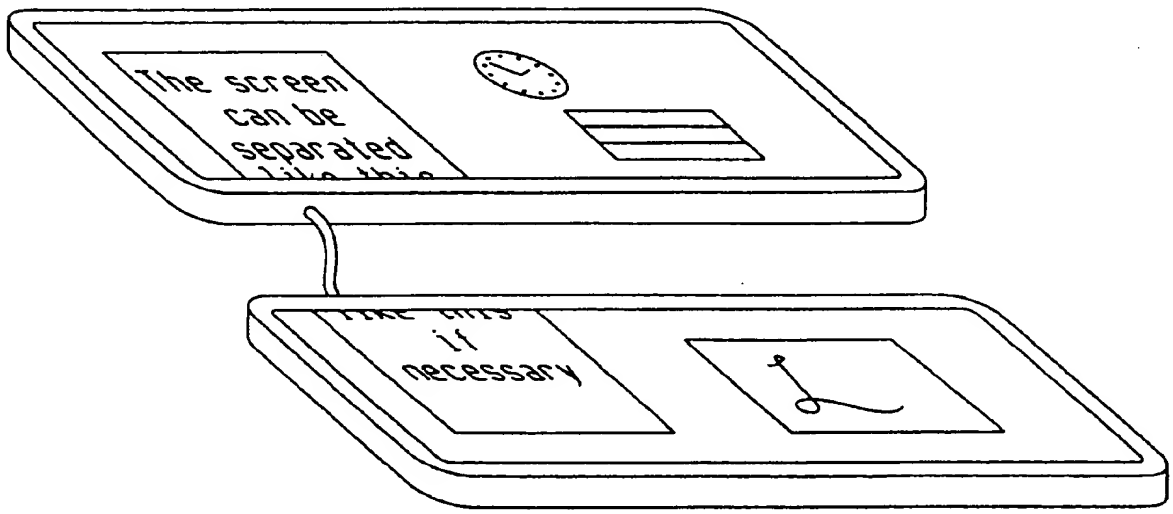
(72) Inventors:
- **Narayanaswamy, Shankar**
  Sunnyvale, California 94086 (US)
- **Rosenthal, Eugene J.**
  Edison, New Jersey 08817 (US)

(74) Representative: **Johnston, Kenneth Graham et al**
Lucent Technologies (UK) Ltd,
5 Mornington Road
Woodford Green Essex, IG8 OTU (GB)

(54) Multi-display electronic devices having open and closed configurations

(57) A portable or other electronic device has two or more display devices or screens that can be used to display different subsets of image signals. The effect is that the device simulates the display capabilities of devices having much larger screens. The device has an open or active configuration, in which the multiple screens are available for displaying image signals, and a closed or inactive configuration, in which some or all of the multiple screens are folded together or otherwise stowed away to reduce the size of the device for storage and/or carrying. By simulating large-display operations, electronic devices according to the present invention are capable of presenting more useable information to the user than is otherwise possible using prior art devices having a single small screen.

FIG. 5



0 898 223 A2

display displaying the full image. The multiple small displays combine to simulate the operations of a single large display. As such, device **100** is able to present concurrently more useable information to the user than would otherwise be available to a user of a conventional PDA that had a single small display.

[0010] Displays **104** and **106** may be any suitable type of display device, including liquid crystal displays (LCDs). In device **100**, a hinge or other similar mechanism may be used to keep the displays together when used in the open, e.g., active, configuration or the closed, e.g., inactive, configuration. A locking mechanism can be used to keep the combined structure rigid when the screens are unfolded. As shown in Fig. 1(b), the different displays need not be co-planar in order for the device to be used in the active configuration.

[0011] Device **100** has two flat-panel displays **104** and **106** which may be less than 5mm thick without a backlight. When the device is in its inactive configuration, the two sides are folded together. For example, if a 5"x5" display area is implemented using two 5"x2.5" displays, the two displays are stored flat against each other. The inactive area is therefore only half of the active area, resulting in a more compact configuration for carrying and/or storing the device.

[0012] Fig. 1(c) shows a perspective view of a portable electronic device in the open configuration, according to an alternative embodiment of the present invention. According to this embodiment, display **102** of Fig. 1(a) and display **104'** of Fig. 1(c) are positioned back-to-back within the top half of the device. In one implementation of this embodiment, the device has backlighting means located behind display **106'**, and displays **106'** and **104'** are transparent. For such an implementation, the backlighting means behind display **106'** will illuminate display **102** when the device is in the closed configuration as shown in Fig. 1(a). In this way, a thinner device with backlighting can be achieved. Furthermore, in certain embodiments, display **102** of Fig. 1(a) and display **104'** of Fig. 1(c) may be implemented as a single display device that is adapted to generate images for both the open and closed configurations and possibly at the same time.

[0013] Fig. 2 shows a block diagram of an electronic device **200**, according to one implementation of the present invention. For example, electronic device **200** may be modified as needed to implement device **100** of Figs. 1(a)-(b). Device **200** has two or more display devices that may be used to display different sets of image signals to create the effect of a larger display.

[0014] In particular, image generator **206** generates image signals for display on display devices **210**. The image signals may comprise any conventional type of image signals, including text, video, graphics, or any combination thereof. Display driver **208** receives the image signals from image generator **206** and distributes appropriate subsets of image signals to the various display devices **210** for display. Each display device **210** operates as a distinct image display device. The effect however of all of the display devices **210** operating together under the control of display driver **208** is the simulation of a larger display device displaying all of the image signals generated by image generator **206**. Image generator **206** and display driver **208** may be implemented on a single processor, either in hardware, in software, or in a combination of both hardware and software.

[0015] Electronic device **200** also has optional local input device **202** and optional remote input device **204**. Local input device **202** may be any suitable device that enables a user to enter information into device **200**, such as a keyboard, a keypad, a stylus for a touch screen, a thumb wheel for scrolling, or a track pad. This information is received by image generator **206** for appropriate updating of the image signals to be displayed. Remote input device **204** may be an antenna, network, or cable port, or other suitable type of interface for receiving information from a remote source. This information is also received by image generator **206** for the update of the images to be displayed. In particular implementations, one or more of the display devices may be touch sensitive to operate as additional input devices of device **200** for the input of user-selected information to be fed back to image generator **206**.

[0016] Fig. 3 shows a block diagram of an electronic device **300**, according to an alternative implementation of the present invention. Electronic device **300** is analogous to electronic device **200** of Fig. 2, except that each display device **210** in device **300** has its own display driver **308** to control the display of subsets of image signals. Image generator **306** and display drivers **308** may be implemented on a single processor, either in hardware, in software, or in a combination of both hardware and software.

[0017] Depending on the implementation, the function of dividing image signals into subsets for display on the various display devices may be performed by either the image generator or the one or more display drivers. Even in device **300** of Fig. 3, where each display driver **308** interfaces with only a single display device, image generator **306** could generate and store the image signals into memory, and each display driver **308** could know which subset of those image signals to retrieve from memory. In any case, the image signals are divided into subsets based on the portions of each image displayed by the various display devices. For example, in the embodiment of Fig. 4, where the display devices display the top and bottom halves of each image, respectively, the image signals are divided into two subsets accordingly. Similarly, in the embodiment of Fig. 6, where the display devices display the top half, lower left quarter, and lower right quarter of each image, respectively, the image signals are divided into three subsets accordingly.

[0018] Figs. 4-6 shows portable electronic devices, according to possible embodiments of the present in-

apparatus of claim 3, wherein at least one display device can be used to display images in the closed configuration.

8. The device of claim 1 or the method of claim 2, or apparatus of claim 3, comprising one display driver for each or some or all of the display devices.

9. The device of claim 1 or the method of claim 2, or apparatus of claim 3, wherein the image generator and the one or more display drivers are implemented on a single processor.

10. The device of claim 1 or the method of claim 2, or apparatus of claim 3, wherein the one or more display drivers are implemented in software, or hardware.

11. An electronic device comprising first and second displays oppositely oriented, such that:

when the device is in a closed configuration, the first display is visible to a user and the second display is hidden from view; and
when the device is in an open configuration, the second display is visible to the user.

12. The device of claim 11, further comprising a third display, such that, when the device is in the open configuration. the second and third displays display different subsets of image signals.

13. The device of claim 11, wherein the first and second displays are mounted back-to-back and further comprising backlighting means located behind the third display, such that, when the device is in the closed configuration, the backlighting means is adapted to illuminate the first display.

14. The device of claim 11, wherein:

when the device is in the open configuration, the device is adapted to operate as a personal digital assistant; and
when the device is in the closed configuration, the device is adapted to operate as a portable telephone.

15. The device of claim 11, wherein the first and second displays are implemented as a single display device adapted to generate images for both the open and closed configurations.

FIG. 1C

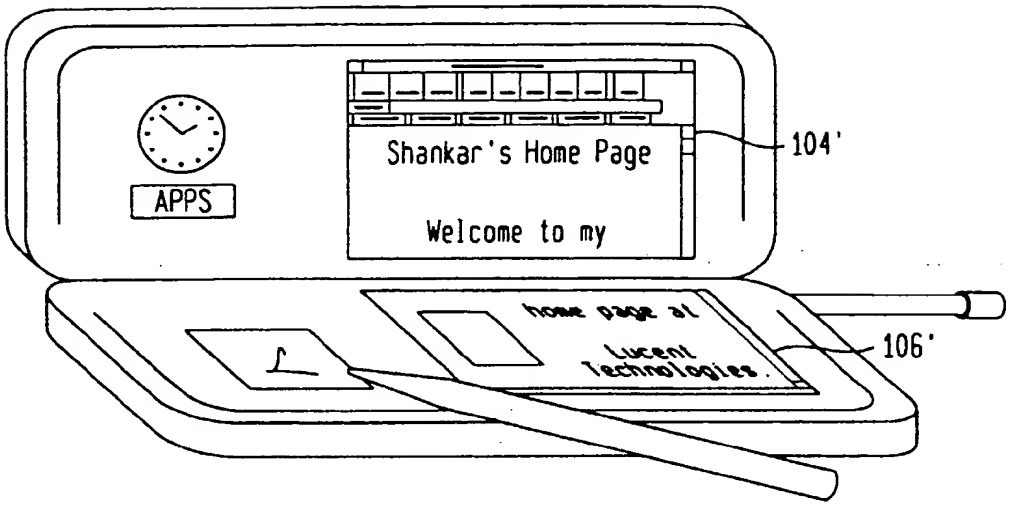

APPS
Shankar's Home Page
Welcome to my
104'
106'

FIG. 2

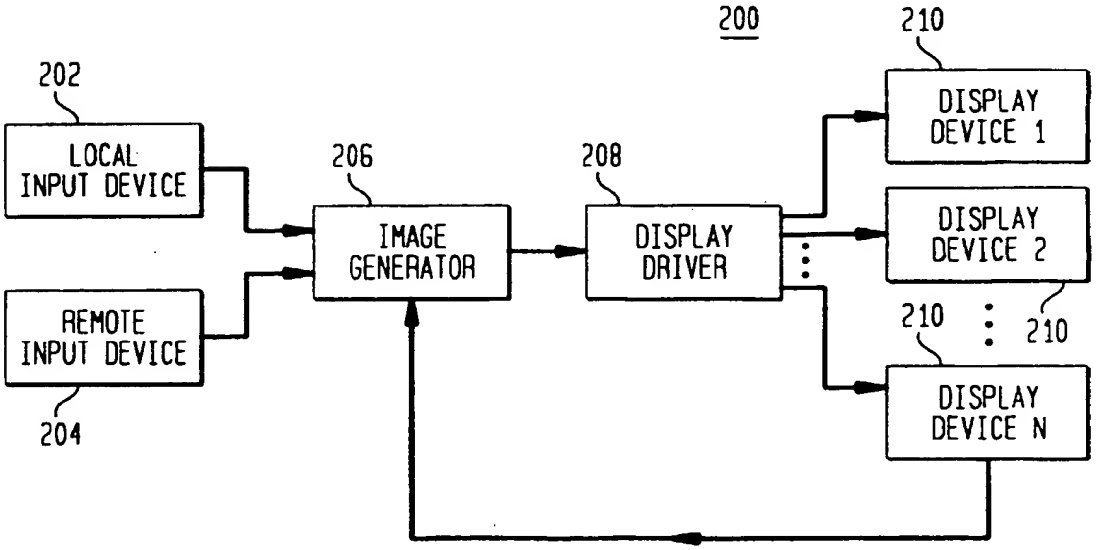

200
202
LOCAL INPUT DEVICE
REMOTE INPUT DEVICE
204
206
IMAGE GENERATOR
208
DISPLAY DRIVER
210
DISPLAY DEVICE 1
DISPLAY DEVICE 2
210
210
DISPLAY DEVICE N

FIG. 5

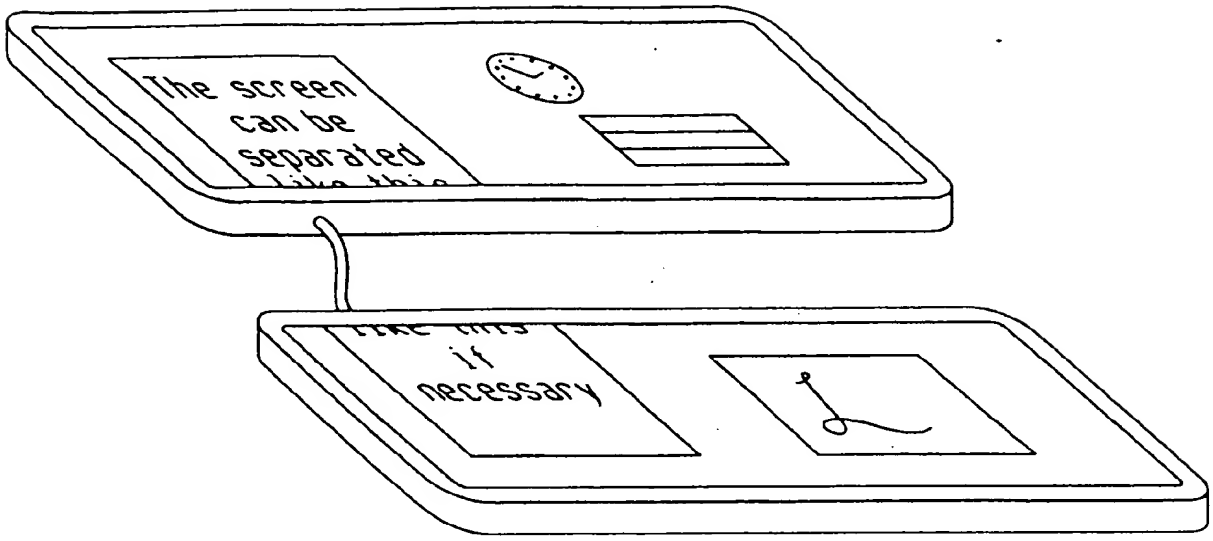
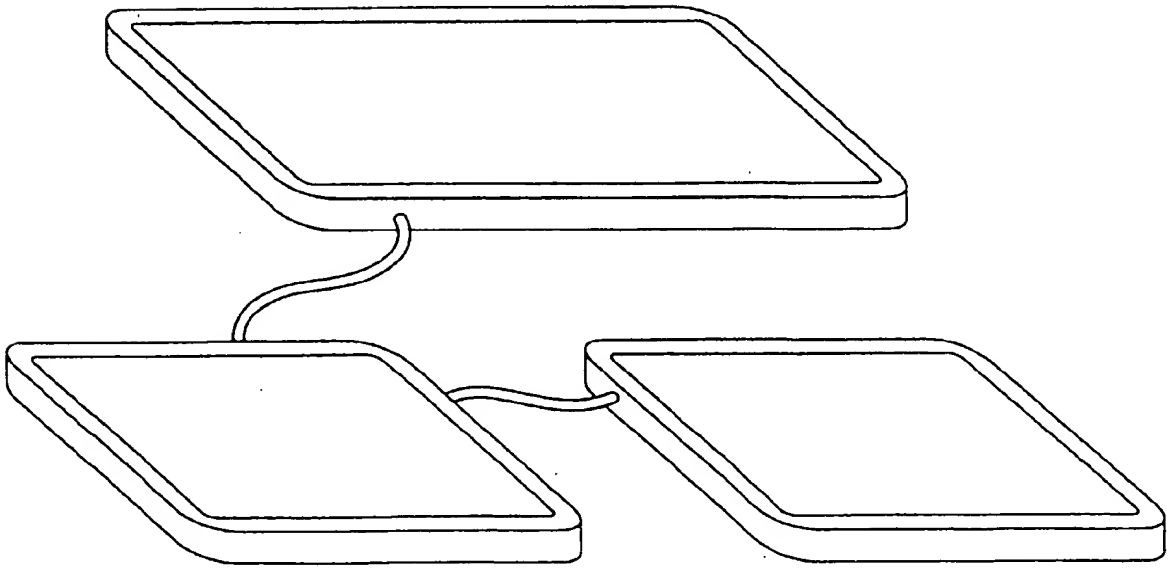


FIG. 6



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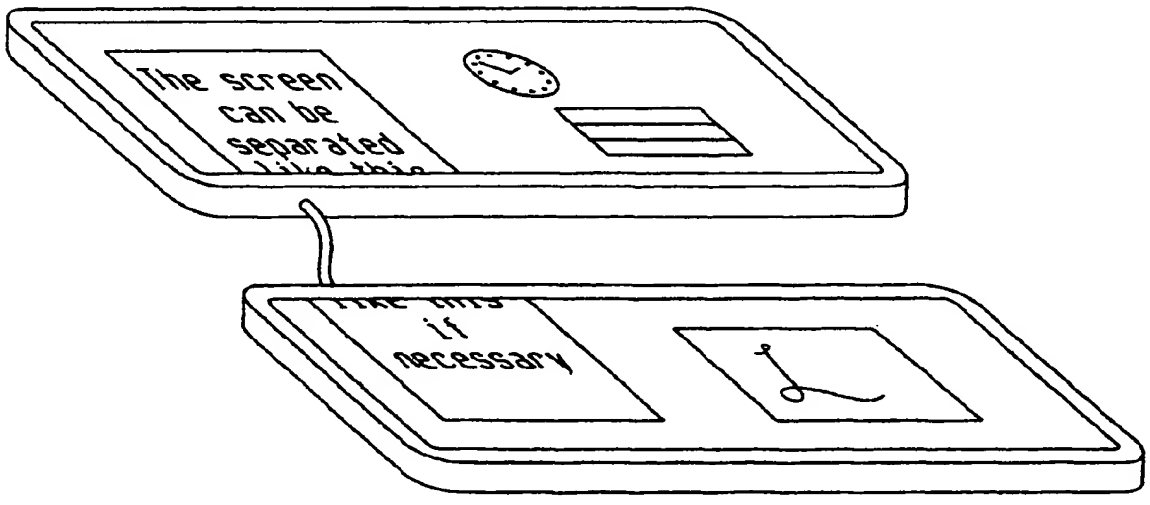

EP 0 898 223 A3

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 30 6391

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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19-01-1999

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